(Searl Magnetics, Inc.) that was attempting to redevelop Searl's SEG. They asked me to serve as Chairman-CEO of STI, a newly formed holding company, and to re-structure the company that also included acquiring the rights to develop and license Searl's technology. We subsequently learned however, that Searl had already signed over such rights to D.I.S.C. Inc. in 1995, but we were finally able to negotiate the legal assignment of these rights to STI from D.I.S.C and Searl.

After several months, it had become quite clear that advanced age and serious heath issues had taken their toll on John Searl. Moreover, his business partner Fernando Morris had blown through well over $600,000 with no material progress toward development of the SEG. Also, he had been engaging in felonious activities that could have resulted in serious problems for STI and its ability to raise adequate financing down the line. Accordingly, in early 2014 the shareholders of STI voted unanimously to rescind all agreements with Searl and Morris, but STI retained all of its rights to the Searl technology acquired from D.I.S.C. We had also come to the conclusion there seemed to be a definitive pattern, based on Searl's previous business relationships, that perhaps answers the question as to why his SEG has never been redeveloped in more than 50 years from the time Searl purported to have first built it!

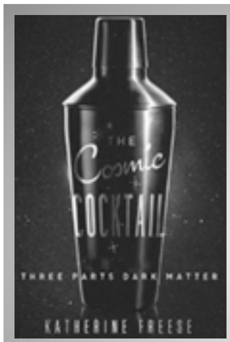
Fortunately, I had been able to locate a large portion of Paul's notes and related information relative to the kinetic magnetic device he had built back in 1986. Accordingly, we have raised additional funding and are now in the process of concentrating our efforts on developing the STG utilizing certain nano materials and techniques that have only recently become available to us. This research and development is going forward under the direction of Bruce Parsons, Ph.D., a very capable and brilliant engineer, with prototyping well under way for this important technology.

The Peter Graneau Memorial Fund

The non-profit New Energy Foundation (publisher of *Infinite Energy*) has established the Peter Graneau Memorial Fund to further the development of Dr. Peter Graneau's research on the liberation of intermolecular bond energy in liquids for the purpose of creating new solar driven electricity generating technologies. This fund will support the construction and testing of prototype generator structures that continuously convert electrical energy to kinetic energy of liquid droplets, enhanced by the liberation of stored energy in the bulk liquid. Energy harvesting mechanisms are then used to convert the droplet kinetic energy back into electrical energy. The goal of the program is to achieve a closed cycle that produces a gain in electrical energy at the expense of the renewable atmospheric heat driven by the sun.

Donations should be made out to the New Energy Foundation and sent to:

New Energy Foundation
Peter Graneau Memorial Fund
P.O. Box 2816
Concord, NH 03302-2816



The Cosmic Cocktail:
Three Parts Dark Matter

Katherine Freese
Princeton University Press, 2014
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Review by George Michael

Editor's Note: This book and review discusses and accepts the standard explanations for dark matter. While Infinite Energy does not have this perspective on the topic, the book might interest readers all the same.

Exciting new research in physics could unlock some of the deepest mysteries of our Universe. For instance, in July 2012, the Higgs boson (also referred to as the "God particle") was confirmed at CERN (the European Council for Nuclear Research), thus completing the Standard Model of particle physics. Despite this monumental discovery, the nature of important elemental properties of the Universe still eludes us. In her book, *The Cosmic Cocktail: Three Parts Dark Matter*, Katherine Freese, the George E. Uhlenbeck Professor of Physics at the University of Michigan, explores the mystery of these unseen properties in the Universe.

Dark matter is believed to be composed of some type of undiscovered fundamental particle—not neutrons, electrons, protons, or quarks—but something altogether different. Although we cannot see dark matter in our telescopes because it does not give off light, astrophysicists believe that it is ubiquitous in our galaxy. An attractive force, dark matter is responsible for holding the stars together in galaxies; for without it, there would not be enough gravity to keep the stars from wandering away. Other than gravity, dark matter does not appear to interact with baryonic (atomic) matter. Conceivably, dark matter particles could pass through our bodies every second, yet we are unaware of them because they do not interact with the strong or electromagnetic forces of the atoms that compose us.

Freese chronicles the history of the search for both dark matter and dark energy. A key figure in the discovery of dark matter was Fritz Zwicky, a Swiss astronomer who worked for most of his career at the California Institute of Technology in Pasadena. While examining the Coma Cluster in 1933, he observed that the galaxies were moving surprisingly fast, far more than could be explained by the gravitational pull of the stars in the cluster. Based on their rapid speeds, Zwicky realized that the stars should have escaped the cluster entirely due to centrifugal force, yet some unseen property held the galaxies together. Zwicky christened this property "dunkel Materie"—German for dark matter. Although he did not know what constituted this mysterious property, he argued for its existence based on its gravitational effects on visible matter.

Although the properties of dark matter cannot be directly seen, their effects can be measured. A variety of astronomical techniques have been used to measure the effects of dark matter. For example, by calculating the speed of objects orbiting around the galactic center, astronomers can determine the amount of mass in the interior of their orbits. In

1978, Vera Rubin and Kent Ford discovered that objects orbiting in the Milky Way galaxy move more rapidly than what would be expected, even at great distances from the Galactic center. But based on the known matter in the galactic disk, the speeds should have fallen off rapidly. The fact that they did not slow down suggested that the galaxy must contain some unseen additional mass which provided strong evidence for dark matter.

As Freese explains, galaxy formation proceeds from the bottom up. Initially after the Big Bang, all particles were distributed rather uniformly throughout the Universe, but over time, small clumps of mass began to form which began exerting extra gravitational pull that dragged in more and more material. By doing so, these clumps merged together to form ever-larger objects, thus eventually creating galaxies and clusters. Without dark matter, the galaxies would not have formed. Astronomers believe that a Galactic halo, composed mostly of dark matter, surrounds the Milky Way and other galaxies. These Galactic halos are not donut-shaped; rather, they are spheres containing dark matter. According to her analogy, Freese likens the stellar disk (the flat part of a spiral galaxy) to a Frisbee contained in a much larger basketball (the Galactic Halo) filled with dark matter.

Numerous candidates have been proffered as dark matter, including anti-matter, neutrinos, MACHOs (Massive Compact Halo Objects), and WIMPs (Weakly Interacting Massive Particles). Of all the candidates the latter two seemed the most promising. Although the argument for MACHOs was a sound one, the research of Freese and her assistant David Graff determined that at most, these objects (which include faint stars, planetary objects, white dwarfs, neutron stars, and black holes) could only account for up to 3% of the mass in the Milky Way galaxy. According to Freese, the smart money is on WIMPs to provide the answer to the dark matter mystery. Besides gravity, their only interactions are by way of the weak force. Another attractive feature to this theory is that the amount WIMPs extant in Universe today has the right abundance to solve the dark matter problem. According to Freese, the number of WIMPs remaining today can be calculated and corresponds with the exact amount required to account for dark matter in the Universe.

One indirect method to detect WIMPs involves searching for physical signs of WIMP annihilation products in the galaxy. Inasmuch as many classes of WIMPs are believed to be their own anti-particles, they annihilate themselves, thus producing a variety of lower-energy particles, for example, positrons, photons, and neutrinos. This annihilation process can occur whenever the density of WIMPs is high enough for them to collide with one another. Freese advises that one of the best places to search for WIMP annihilation is toward the center of the Milky Way insofar as computer simulations indicate that this is the region with the peak dark matter density. Alas, much competing astrophysical phenomena also occur there, such as x-ray and other emissions from matter that is falling into the supermassive black hole at the galactic center. As a consequence, telltale evidence is still elusive.

Alternatively, physicists can seek to simulate similar conditions in the Large Hadron Collider at CERN, which is the world's largest particle physics laboratory. Located 100 meters underground, the Large Hadron Collider is a massive 27 kilometer circular tunnel in which particles are collided together at nearly the speed of light. Optimistically, Freese predicts that we will have an answer for the dark matter problem soon.

There is even a project to develop a dark matter detector using DNA. The basic idea is that when a WIMP strikes the nucleus in the target material, it will knock the nucleus into a periodic array of single-stranded DNA. Researchers could then look at the trail of the broken DNA to reconstruct the path of the nucleus. Inasmuch as the WIMP is typically moving in the same direction as the nucleus, researchers could determine the path of the incoming dark matter particle.

While dark matter works as an attractive force, dark energy is a repulsive force believed to be responsible for driving the galaxies away from one another at an accelerating pace. In the 1990s, two groups of astrophysicists discovered dark energy by observing distant supernovae—massive luminous explosions of dying large stars. These researchers determined that the supernovae were significantly fainter than would be expected and postulated one reason for this was that the galaxies were accelerating away from us. This discovery occasioned a paradigm shift in cosmology, for we now think that more than two-thirds of the Universe consists of dark energy. Acting as a force of anti-gravity, dark energy appears to cause every point in the Universe to accelerate away from every other point.

One method to observe the effects of dark energy is by using "standard candles," that is, objects that shine with the same luminosity, or brightness, regardless in which epoch they existed. The best standard candles are Type IA supernovae because they are equally luminous no matter where or when they form. Although occurring rarely in any particular galaxy—about one or two explosions per millennium per galaxy—they are as bright as ten billion suns and can be seen at great cosmological distances. No matter how distant, or how far back in time they take place, astronomers know the exact brightness of these explosions. Inasmuch as Type IA supernovae can observed many light years away, they are in a sense a window into the distant past. To their surprise, astronomers discovered that the ancient supernovae are 20% dimmer than had been expected. The implication was that the supernovae are moving away from us at an accelerating speed. This finding was counterintuitive because astronomers expected to find that the expansion of the Universe was decelerating. According to the Big Bang theory of cosmology, all mass and energy in the Universe were once condensed into a single point that eventually erupted in a violent explosion in which the fabric of both time and space came in to existence. Because gravity is an attractive force, it was assumed that the expansion of the Universe would slow down over time as the objects composed of baryonic matter (and dark matter) contained therein would draw one another together. It is believed that the repulsive force of dark energy is fuelling the accelerating expansion of the Universe.

For Freese, the most likely explanation for dark energy is vacuum energy. According to quantum theory, regions of space devoid of matter and light will still contain some energy. In this quantum vacuum, fleeting particles continually pop in and out of existence, billions of times every second, on every conceivable frequency, and in every possible direction as determined by Heisenberg's Uncertainty Principle. According to the most recent estimate, the breakdown of the Universe is as follows: 5% baryonic matter and energy, 26% dark matter, and 69% dark energy. But unlike baryonic matter, the two quantities of dark matter and dark energy cannot be transmuted into each another in the style of Einstein's famous equation $E = mc^2$.

Ominously, Freese points out that dark energy could have dire consequences for the future of our Universe. Ultimately, the fate of the cosmos depends upon its geometry. If the Universe has a spherical geometry, it will eventually collapse to a high-density Big Crunch, perhaps, even rebound, oscillating with alternating periods of expansion and collapse. Cosmic background radiation, however, suggests that the Universe has a flat geometry. As a consequence, the Universe is most likely headed for a Big Chill, that is, entropy will continue to increase as its temperature approaches absolute zero. Although biological life could not exist in an ever colder Universe, conceivably, some type of post-biological life might be able to survive. But even mechanical life forms would still have to dispense with the heat generated by the computations they perform. Citing the research of Lawrence Kraus and Glenn Starkman, Freese notes that even in an increasingly colder Universe these creatures would fry to death in the thermal bath of Hawking radiation if the value of the dark energy density remains constant. (Stephen Hawking argued that black holes emit particles—so-called Hawking radiation—due to the Uncertainty Principle. Over short distances, particles and radiation are able to move faster than the speed of light and by doing so, can escape the event horizon of the black hole.) But Freese sees a possible loophole in this dismal scenario, noting that this heat death could be avoided if the dark energy density is not constant, but decreases as time goes by. As she explains, there was a previous epoch in which dark matter decelerated the expansion of the Universe. But roughly eight billion years ago, dark energy won out and the Universe switched to acceleration. Ironically, this period commenced when conditions in the Universe became suitable for life. If the density of dark energy decreases, life, albeit post-biological, could theoretically persist indefinitely.

Perhaps someday there could be practical applications for dark matter and dark energy as alternative energy sources. According to some speculations, a virtual unending supply of so-called zero-point energy might one day be extracted from the quantum vacuum. Understandably, scientists are highly skeptical of the prospects of using zero-point energy in any practical sense. Readers of this magazine might be disappointed that Freese is silent on this issue. Nevertheless, she brings to bear her many years of experience of research in this vitally important field of astrophysics. As such, *The Cosmic Cocktail* will be of great interest to students of cosmology and theoretical physics.